(19)日本国特許庁（ＪＰ）

(12) 公開特許公報（Ａ）

(11)特許出願公開番号

特開平11－138422

(43)公開日　平成11年(1999)５月25日

(51)Int.Cl.^{6}	識別記号	ＦＩ	
Ｂ２４Ｂ　37/00		Ｂ２４Ｂ　37/00	Ｃ
1/00		1/00	Ａ
Ｈ０１Ｌ　21/304	３２１	Ｈ０１Ｌ　21/304	３２１Ｍ

審査請求　未請求　請求項の数６　ＦＤ　（全　８　頁）

(21)出願番号　特願平９－317735

(22)出願日　平成９年(1997)11月５日

(71)出願人　596137955
スピードファム株式会社
神奈川県綾瀬市早川2647

(72)発明者　清野　敏廣
神奈川県綾瀬市早川2647　スピードファム株式会社内

(72)発明者　箱守　駿二
神奈川県綾瀬市早川2647　スピードファム株式会社内

(72)発明者　天野　健史
神奈川県綾瀬市早川2647　スピードファム株式会社内

(74)代理人　弁理士　田中　宏　（外１名）

(54)【発明の名称】　半導体基板の加工方法

(57)【要約】

【目的】本発明方法は、半導体ウェーハの鏡面仕上げにいたるまでの一連の製造加工プロセスにおいて、加工ダメージ層の発生を抑制する加工プロセスに関わる。

【構成】ラッピング、エッチング、ポリッシング等の工程よりなる、ＩＣ、ＬＳＩあるいは超ＬＳＩ等の原材料である鏡面仕上げの半導体ウェーハを製造加工する方法において、ラッピング工程を終えたウェーハを、砥粒を固定した研磨パッドを表面に貼付した加工機の定盤面に配置し、乾式で押圧回転を行う加工工程を組み込むことを特徴とする半導体ウェーハの加工方法。

【特許請求の範囲】

【請求項１】　ラッピング、エッチング、ポリッシング等の一連の工程よりなる半導体ウェーハの加工方法において、ラッピング工程を終えたウェーハを、砥粒を固定した研磨パッドを貼付した加工機の加工作用面に設置し、乾式で押圧回転を行なう加工工程を組み込むことを特徴とする半導体ウェーハの加工方法。

【請求項２】　研磨パッドに固定する砥粒が酸化珪素、酸化セリウム、酸化クロム、炭酸カルシウム、炭酸バリウム、酸化マンガンおよび酸化ジルコニウムよりなる砥粒微粉のうち少なくとも一つであることを特徴とする請求項第１項記載の半導体ウェーハの加工方法。

【請求項３】　研磨パッドに固定する砥粒が平均粒径０．０１ミクロンから２０ミクロンの微細砥粒であることを特徴とする請求項第１項および第２項記載の半導体ウェーハの加工方法。

【請求項４】　研磨パッドが、不織布、合成樹脂、合成樹脂発泡体、合成皮革あるいは布帛等をシート状にしたもの、あるいはその一種あるいはそれ以上を積層してシート状にしたものであることを特徴とする請求項第１項ないし第３項記載の半導体ウェーハの加工方法。

【請求項５】　研磨パッドが、砥粒内添型のものであることを特徴とする請求項第１項ないし第４項記載の半導体ウェーハの加工方法。

【請求項６】　乾式加工を行う加工機が、上下両面に定盤を有する両面式のラッピング加工機であることを特徴とする請求項第１項ないし第５項記載の半導体ウェーハの加工方法。

【発明の詳細な説明】

【０００１】

【発明が属する技術分野】本発明は、ＩＣ、ＬＳＩあるいは超ＬＳＩ等の素材であるシリコン単結晶や化合物系の単結晶のインゴットのスライシング以降、即ちアズカットウェーハから鏡面ウェーハまでの一連の加工方法の改良に係わる。

【０００２】

【従来の技術】従来、ＩＣ、ＬＳＩあるいは超ＬＳＩ等の素材である鏡面仕上げを施したシリコンウェーハあるいは化合物系のウェーハ（以下鏡面ウェーハと総称する）は以下の一連の製造プロセスを経て製造されるのが一般的であった。すなわち、単結晶引き上げ法によって製造されたシリコン等の単結晶インゴットの外周研削を行なった後、結晶方向の位置決めの為の例えばオリエンテーションフラット加工を施し、内周刃ソーあるいはワイヤソーにてスライシングを行いアズカットウェーハを得る。このアズカットウェーハを、ベベリングによる外周部の面取りを行なった後、両面ラッピング加工により均一な厚みと平行度、平面度及びある程度の面粗さを持つまでに仕上げる。得られたラップドウェーハを酸またはアルカリにてエッチング加工を行ない加工変質層を除去、然るのちポリッシングによる鏡面仕上げを行う。ここで得られる鏡面ウェーハは優れた面粗さと形状精度を持ったものでなくてはならない。

【０００３】近年、ＩＣ、ＬＳＩあるいは超ＬＳＩの記憶容量のアップと生産性の向上といった必要性から、ウェーハの加工精度、特に寸法安定性の向上と同時にウェーハ自体のサイズの大型化の進行が著しく、加工プロセスにおける効率や能率あるいは歩留まりの向上が極めて重要な要素となりつつある。特に、シリコンウェーハの場合はその原料となるシリコン単結晶インゴットの製造技術が向上し、直径８インチ、１２インチといった大口径のものの生産も行われるようになって来ている。従って、このような大口径のものの加工を生産効率よく行うためには、従来の小口径用の加工プロセスから変わりつつある。

【０００４】上述のプロセスにおいて特にポイントとなるのはラッピング工程、エッチング工程及びポリッシング工程である。ラッピング工程においては、例えば金属性の定盤を上下両面に配置した両面ラッピング加工機を用い、その上下定盤間にウェーハを押圧挾持し定盤を回転させ、その加工面にアルミナ系の砥粒スラリーを供給して行なう。この加工の目的は、スライシングによる厚みのバラツキやソーマークを除去し、かつ均一な厚みと平行度、平面度と精密な面粗さを得ることにある。砥粒の作用によってウェーハの面が少しずつ除去されて行き、平坦かつ均質な面が創成されて行く。この場合、生産性と作業能率の向上のため数十枚のウェーハを同時に加工する方法が取られるのが一般的であるが、上述のようにウェーハの口径が大型化して行くと、加工精度の維持が難しくなる。加工においては剛性の高い定盤と砥粒との作用による高い応力が起因してウェーハの単結晶が歪みを受け、単結晶として要求される性能を阻害する加工ダメージ層が形成される。この加工ダメージ層は半導体としては全く使えない部分であるので、次のエッチング工程において除去されねばならない。

【０００５】上述の加工ダメージ層の深さはラッピング加工条件によっても異なるが、一般的には数ミクロンから十数ミクロンに及ぶ。このダメージ層の除去には、混酸あるいはアルカリ液でのエッチング手法が使われる。酸またはアルカリの化学的作用によりウェーハの表面が侵食され除去されるのであり、液の種類、温度、浸漬時間等の諸条件を調節し、除去に必要な厚さを調整する。この工程においては、加工ダメージ層の除去はできるが、ラッピング工程で得られた形状を再び崩し、また平行度、平面度等を悪化させる。ここで用いられる酸としては酢酸、弗酸、硝酸等を適宜混合した混酸があげられ、また、アルカリとしては水酸化カリウムの水溶液を挙げることができるが、比較的均質なエッチングができることから、近年はアルカリエッチングが主流となりつつある。また、この工程においては、例えば弗酸や水酸

化カリウムといった有害物を多量に使用するため、その廃水処理に多大の負荷がかかる等の問題点が指摘されている。エッチング後のウェーハは洗浄、乾燥され、検査による選別を経て、最終的な鏡面を得るために次のポリッシング工程に移る。

【０００６】ポリッシング工程においては、前段のエッチング工程において悪化した形状精度を是正し、均一な厚みと優れた平行度、平面度を得るとともに極めて精密な鏡面を得ることを目標にして加工を行なうのであるが、加工機は不織布等からなるポリッシングパッドを貼付した定盤を有するポリッシング機が使用される。ポリッシングは一般的には下定盤を有した片面タイプを用いるが、特に形状精度を出すための１次ポリッシングでは、やや粗く硬目の不織布を上下定盤に貼付した両面タイプのものが使用され、また最終ポリッシング工程では、スェード調の不織布を下定盤に貼付した片面タイプのものを使用する。不織布を用いる理由は、加工ダメージを与えずにエッチングで悪化させた形状を修正しながら鏡面を得るためであるが、強い摩擦力によるウェーハの局部的な温度上昇をはかることで水酸化カリウム（ＫＯＨ）などのアルカリ水溶液の化学的作用（反応速度は、温度に依存する）と、水溶液に分散させた酸化珪素などの超微粉末砥粒による除去作用との複合作用に負うところが大きい。いわゆるメカノケミカルポリッシングと言われる加工であるが、化学腐食作用によりできた軟質の反応生成物を、ウェーハ（被加工物）より軟らかい超微粉末砥粒で除去することにより、ラッピングなどの物理的加工で生ずる加工ダメージ層を生成させずに精密な鏡面をえることができる。この加工速度はラッピングの１／１０以下の緩やかな除去速度であるため、形状修正の効果が少なく、除去すべき深さ（加工ダメージ層）が深ければ深いほど加工時間が比例的に増える問題がある。

【０００７】以上述べた通り、鏡面ウェーハは上述の一連の製造プロセスを経て製造されるのが一般的であったが、この工程においてはその前半のラッピング工程を経ることによって、半導体素材としては使うことのできない加工ダメージ層が形成されるということ、及びその加工ダメージ層を除去するためのエッチング工程が必要とされ、そのことによりウェーハの形状精度を悪化させるのみならず、そのエッチング工程が作業環境的に見て好ましくなく、またその廃水処理装置に及ぼす負荷も大変高いこと、およびポリッシング工程における形状修正の効果が少なく、加工時間も長いということが大きな問題点として指摘されていた。このような問題点の解決方法の一つとして、例えば、ダイヤモンド微細砥粒を固定砥粒として埋め込んだグラインダー（カップ状砥石）による加工がある。固定砥粒、すなわちグラインダーによる加工は、遊離砥粒を利用したラッピング手法に比較して加工ダメージ層の深さが１０分の１程度になり、従って次工程であるエッチング工程での除去量を少なくさせる効果があり、エッチングによる加工精度の悪化を抑制することが期待できる。しかしながら、このグラインダー加工の場合枚葉式の加工でしかも片面ずつの仕上げを基本とするため、複数枚を両面同時加工を基本とするラッピング加工に比較して生産効率が低い上、反りの問題が出やすく、また加工痕が方向性のある線状痕であるため特に深い条痕があった場合、次のエッチング工程でそれをさらに拡大する危険性を有する。すなわち、ダイヤモンド砥粒の刃先管理技術が極めて難度高く現段階ではまだ実用化には至っていない。また、ラッピング定盤の代わりに平板状砥石定盤を用いてラッピングを行う方法も提案されているが（特公平６－７１７０８）、これは上述と同様の問題点を有するのと同時に定盤の面の形状（平面度、平行度）の維持管理が難しく完全な方法とは言い難かった。更にラッピング工程において使用する研磨液中の砥粒粒度を細かくすることも対策として考えられるが、これをＦＯ１５００番より細かい粒度にするとウェーハ表面にスクラッチ（線状傷）が発生しやすくなり、実用的ではなかった。

【０００８】

【発明が解決しようとする課題】現状での一般的なラッピング工程においては、鋳鉄定盤を用い、砥粒番手１２００番（平均粒径：７～８ミクロン）のＦＯ砥粒を含むスラリーを加工液として用いるがこれにより得られる表面粗さはＲａで０．１５ミクロン程度でありまたＴＴＶ（トータルシックネスバリエーション）は１．０ミクロン程度である。同時に加工ダメージ層の深さは大略１０～２０ミクロン程度となる。即ち、ラッピング後のエッチング工程においてはこの１０～２０ミクロン程度の加工ダメージ層を除去するのであるが、これにより表面粗さは向上するものの、ＴＴＶは１～３ミクロン程度にまで悪化する。本発明者等は、この現状に鑑み、鋭意研究を行なった結果、以下のことを解明するに至ったものである。すなわち、ラッピング工程においては、極めて剛性の高いラッピング定盤と硬度の高い微細砥粒を使用するため高い応力がウェーハ表面に作用し単結晶構造の破壊が行われ結晶内部に加工ダメージ層を生成させる。よって、この応力を軽減することが加工ダメージ層の深さを減らすことになるのであるが、単に物理的に応力を軽減する方法、例えば加工圧力を低くする方法では加工時間を延長することになり、問題解決にはならない。

【０００９】本発明者等は、通常のラッピング加工を行なった後に、既に得られた形状精度を崩さない方法で、加工ダメージ層の除去のみを行なう方法について検討を行なった結果、通常のラッピング加工の後に、定盤の上に不織布等を貼付したものに研磨用の微細砥粒を固定せしめた研磨布を用いて、ある一定の条件下で該研磨布による加工を行なえば、鋳鉄等の定盤の剛性が緩和され、既に得られた面の形状精度を大きく崩すことなく加工ダ

メージ層の除去が行なえることを見出し本発明方法を完成したものである。本発明の目的は、上述の通り特にＴＴＶ等形状精度に大きな影響を与えるエッチング工程の省略、あるいはエッチング工程での条件を軽減することでその除去量を少なくさせるための改良された一連の鏡面ウェーハの加工プロセスを提供しようとするものである。

【００１０】
【課題を解決するための手段】上述の目的は、ラッピング、エッチング、ポリッシング等の一連の工程よりなる半導体ウェーハの加工方法において、ラッピング工程を終えたウェーハを、砥粒を固定した研磨パッドを貼付した加工機の加工作用面に設置し、乾式で押圧回転を行なう加工工程を組み込むことを特徴とする半導体ウェーハの加工方法にて達成できる。研磨パッドに固定する砥粒が酸化珪素、酸化セリウム、酸化クロム、炭酸カルシウム、炭酸バリウム、酸化マンガン及び酸化ジルコニウムよりなる砥粒微粉のうち少なくとも一つであることが好ましい。そしてその砥粒の粒度は平均粒径０．０１ミクロンから２０ミクロン程度のものが選択的に使用される。また、研磨パッド用の素材としては、不織布、合成樹脂、合成樹脂発泡体、合成皮革あるいは布帛等をシート状にしたもの、それ等を一種あるいはそれ以上を積層してシート状にしたものが用いられる。これ等のパッドの製造工程中に、砥粒微粉末を添加して砥粒内添型のものとしてもよいし、また加工時に砥粒微粉末を供給してパッドに砥粒を半固定にするようにしてもよい。更に、この両者を組み合わせるようにしてもよい。この加工を行う装置としては、特に限定を受けるものではなく、片面あるいは両面のラッピング加工機、両頭型の研磨機等を任意に使用することができるが、特に上下両面に定盤を有するラッピング加工機を用いることが好ましい。

【００１１】
【発明の実施の形態】本発明でいうウェーハとは、シリコン単結晶、あるいはガリウム／砒素などの化合物半導体単結晶のインゴットをスライシングしたものであって、前述の諸工程を経て鏡面仕上げのウェーハとなすものである。鏡面仕上げを施したウェーハは、その後のデバイス工程において、ＩＣ、ＬＳＩ等のベースとなるチップに仕上げられて行く。複雑かつ微細、精密な回路をこのデバイス工程においてウェーハ面に書き込んで行くのであるから、その前段階のウェーハ工程においては、少なくとも書き込みを行う面は、極めて精密な面粗さと、形状精度を持ったものでなくてはならない。一般的に鏡面ウェーハに要求される数値はＴＴＶ１．０ミクロン以下、厚さ７２０ミクロン、鏡面側の面粗さＲａ０．０００２ミクロン程度である。本発明方法においては、まず通常のラッピング工程によりウェーハの厚さのバラツキを修正し、好ましい平行度と平面度および面粗さを持ったラップドウェーハを得るのであるが、ここでのラップドウェーハとは大略次の如き数値を持ったものである。すなわち、厚さ：７６０ミクロン、ＴＴＶ：１．０ミクロン以下、面粗さ：Ｒａ０．１５ミクロン程度であり、かつその両面には、１０～２０ミクロン程度の加工ダメージ層を有する。

【００１２】この加工ダメージ層を持ったラップドウェーハを、本発明でいう砥粒を固定した研磨パッドで研磨液を供給することなく乾式で研磨を行なう（以降乾式研磨と記載する）ことにより、該加工ダメージ層の全てまたはその一部を効果的に除去することができる。ここでいう研磨パッドとは以下の如きものをいうのである。即ち、その基材となるものは例えば、合成繊維、天然繊維を織あるいは編加工した布帛類、同じく合成繊維、天然繊維を使用したスパンテックスや、フェルト状あるいはスェード状に仕立てた不織布、合成樹脂や合成樹脂の発泡体、布帛あるいは不織布に合成樹脂を含浸加工した合成皮革類、あるいはこれらの素材を一種あるいはそれ以上積層複合化したもの等を挙げることができる。これ等の素材を０．２～数mm程度の均一な厚みを持ったシート状にして用いることができる。これ等のシートはミクロ的に見ると、その表面はボイド構造であったり、繊維同士の交絡による微小起伏を有するものであるから、この部分に砥粒粉末を均質に施与してやれば砥粒微粉末は該ボイドや繊維の間隙に入り込み、固定されることになる。この状態で軽く樹脂処理を行なえば、その固定の状態は更に強固なものとなる。また、表面に固定された砥粒量が不足であったり脱落等で不足した場合は、加工の段階でその間に砥粒を供給してやれば、その不足を補うことは可能である。上述の研磨パッドがその基材の製造時あるいは加工時において、微細砥粒の粉末をその内部に内添した型のものであれば、上述の乾式研磨の効率と安定性をより優れたものとすることができる。

【００１３】また、ここで用いる微細砥粒粉末の種類は特に限定を受けるものではないが、ウェーハ面に特に強い応力を与えることのないように、被加工体より硬度の低いものあるいは同程度のもの、具体的には被加工体が新モース硬度で８の数値を持つシリコンウェーハの場合は、同等またはそれ以下の硬度の酸化珪素、酸化セリウム、酸化クロム、酸化マンガン、炭酸カルシウム、炭酸バリウム、酸化ジルコニウム等から選定されることが好ましい。また、その粒度は、その前工程であるラッピングで得られた面粗さを悪化させることのないものであることが望ましく、具体的には０．０１～２０ミクロン程度の平均粒径を持つものであることが望ましい。

【００１４】実際の加工においては、前工程がラッピング加工であり、本乾式研磨工程の目的が前述の通り、両面ラッピング加工で生じたウェーハの両面に発生した加工ダメージ層の除去にあるのであるから、前述の研磨布を加工機の定盤面に貼付して精度よく、効率よく加工を行なうためには、加工機も、前工程と同じく両面方式に

よる加工であることが好ましい。具体的には、上下両面に定盤を有する両面加工機の面に、前記研磨布を貼付して加工することが好ましい。加工に当たっては、前記研磨布を上下両面に貼付した両面加工機の定盤の間にラップドウェーハを挟持し、研磨液を供給することなく上下定盤を一定の圧力で押圧しつつ回転、同時にラップドウェーハも、それを把持するキャリアプレートと太陽歯車およびインターナルギアの動きで自転せしめ、それらの作用で加工を行なう。剛性の強い鋳鉄定盤等に比較して、研磨布にクッション性のあること、並びに砥粒自体が、ラッピング工程で使用されたアルミナやＦＯ砥粒に比較して軟質であるので、被加工物であるラップドウェーハに対して応力が低くてダメージを与え難い。従って、この加工を行なうことにより、ラッピング工程で得られたＴＴＶのレベルを悪化させることなく、加工ダメージ層の大部分を除去でき、しかも湿式での加工に比較して加工速度が数倍大きい。

【００１５】ついで、ここで得られたウェーハを次の工程であるエッチング工程で処理するのであるが、加工ダメージ層の深さが２～３ミクロン程度に抑えられ、表面粗さＲａも０．０００５ミクロン程度に改善されているため、エッチングによる除去量を、従来の２０～３０ミクロンから５ミクロン程度にまで軽減することができて、従来のエッチングによるＴＴＶの悪化量も１～３ミクロンから０．５ミクロン以下にまで軽減することが可能となる。

【００１６】上述の如く、エッチングによるＴＴＶの悪化量が大きく軽減されるため、次工程であるポリッシング工程における形状修正に要する負荷が少なくなり、加工に要する時間を飛躍的に短縮することができる。具体的には、従来、エッチング工程において悪化した形状精度を是正し、均一な厚みと優れた平行度と平面度を得ることを主目的とした一次ポリッシングに要する時間を大きく短縮することを可能にする。

【００１７】

【実施例及び比較例】以下実施例をあげて本発明方法を具体的に説明するが、それにより特に限定を受けるものではない。また、以下の実施例および比較例においては２００mmサイズのアズカットシリコンウェーハの加工を行なうものであり、使用された装置、消耗品、加工条件および評価実験の方法は以下に示す通りである。

＜ラッピング工程＞
加工機：両面ラップ盤２４Ｂ－５Ｌ型（スピードファムジャパン社製）
定盤外径：１，５９２mm　定盤内径：５５４mm　定盤厚さ：７０mm
加工液：ＦＯ＃１２００、３０重量％スラリー
ワーク：２００mmアズカットシリコンウェーハ
加工条件：
上定盤回転数；－１０ｒｐｍ（時計回り）
下定盤回転数；４０ｒｐｍ（反時計回り）
太陽歯車回転数；１８ｒｐｍ（反時計回り）
インターナルギア回転数；１０ｒｐｍ
加工液流量；１０００ｍＬ／分　加工除去量；８０μｍ

＜乾式研磨工程＞
加工機：両面ラップ盤２４Ｂ－５Ｌ型（スピードファムジャパン社製）
定盤外形：１，５９２mm　定盤内径：５５４mm
加工圧力：３５ｋＰａ
上定盤回転数：－１０ｒｐｍ（時計方向回り）　下定盤回転数：４０ｒｐｍ
太陽歯車回転数：１８ｒｐｍ（反時計方向回り）
インターナルギア回転数：１０ｒｐｍ
パッド材：ＳＵＢＡ８００（ロデール・ニッタ社製）に平均粒径０．１ミクロンの炭酸バリウムを半固定状態にして使用
加工除去量：５０ミクロン（片面２５ミクロン）

＜エッチング工程＞
液組成：１（弗酸）／１（硝酸）／８（酢酸）
浸漬時間：１分間液浸漬後、１５分間リンシング

＜ポリッシング工程＞
加工機：ポリッシング装置５９ＳＰＡＷ－II（スピードファムジャパン社製）
定盤直径：１，５０４mm
加工圧力：１次研磨；１５ｋＰａ　２次～４次；１０ｋＰａ以下
定盤回転数：４０ｒｐｍ
加工液流量：１次～３次；６Ｌ／ｍｉｎ（循環）　４次；６Ｌ／ｍｉｎ
パッド材：１次；ＳＵＢＡ８００　２次～３次；ＳＵＢＡ４００
４次；ポリテックス

〈評価実験方法〉評価対象となる各加工段階よりサンプリングしたウェーハを垂直にたて、下端よりライトエッチング液に徐々に浸漬してゆき、（経過）時間の差によって図１のように緩い角度５で斜めにエッチングする方法（アングルエッチング）で標本を作成し、結晶の状態（加工ダメージ層の程度と深さ）を調べた。図１（ａ）はウェーハ１の正面図であり図１（ｂ）はその側面図である。ライトエッチング液の浸漬面を破線２で示す。加工ダメージ層の状態は、Ｘ線トポグラフ法による写真で観察し調べたものであり、加工によるダメージが強いほど黒点が多く観察される。エッチングされていないウェーハ表面とエッチングされた各部分のＸ線トポグラフ写真の撮影を行ない、黒点の観察されなくなった点を求め、その部分の深さ、すなわちダメージ層の深さ６をエッチング角度から計算で求めた。

【００１８】実施例

インゴットから切断したアズカットウェーハの外周をベ

ベリングしたものを、更にラッピング加工し、得られたラップドウェーハを出発材料とした。このラップドウェーハ材料を上述の条件にて乾式研磨加工を行なった。ここで得られた研磨加工後のウェーハを供試料とし、上述の評価実験方法にて観察を行なった。図２はその結果を示すＸ線トポグラフ写真であり、図２（ａ）は乾式研磨した表面でありその表面から約５ミクロンの深さの部分の状態を示す図２（ｂ）の写真とを比較するとその状態はほとんど変わらず、加工ダメージ層の深さは５ミクロン以下であることがわかった。

【００１９】比較例１
インゴットから切断したアズカットウェーハの外周をベベリングしたものを、ラッピング加工し、得られたラップドウェーハを供試料とし、上述の評価実験方法にて観察を行なった。図３はその結果を示すＸ線トポグラフ写真であり、ラッピングを行った表面の写真図３（ａ）からは、明らかに加工ダメージやクラックがあることが観察されるが、その表面から約２０ミクロンの深さまでは徐々にＸ線トポグラフの黒点が減少してゆき、２０ミクロンの深さ（図３（ｂ）の写真）でほぼ一定に達することが観察された。すなわち、通常のラップドウェーハにおいてはその加工ダメージ層の深さは、約２０ミクロンであることが判った。

【００２０】比較例２
インゴットから切断したアズカットウェーハの外周をベベリングしたものを、ラッピング加工し、更に上述の条件にてエッチングを行なったものを供試料とした。この供試料につき、上述の評価実験方法に従って観察を行なった。図４はその結果を示すＸ線トポグラフ写真であり、図４（ａ）はエッチングを行なった表面を示し、その表面から約５ミクロンの深さの状態を示す図４（ｂ）の写真とを比較するとその状態はほとんど変わらず、従って通常のエッチドウェーハの場合は、加工ダメージ層の深さは実用的に皆無であることがわかった。

【００２１】比較例３
実施例で得られた乾式研磨後の供試料を、更に上述の条件にてポリッシングを行なったものを供試料とした。この供試料につき、上述の評価実験方法に従って観察を行なった。図５はその結果を示すＸ線トポグラフ写真であり、図５（ａ）はエッチングを行なった表面を示し、その表面から約５ミクロンの深さの状態を示す図５（ｂ）の写真とを比較するとその状態はほとんど変わらず、従って本発明の乾式研磨を行なった後にポリッシング加工を施した場合の加工ダメージ層の深さも実用的に皆無であることがわかった。

【００２２】
【発明の効果】以上の結果から明らかな通り、本発明になる方法にて半導体ウェーハの加工を行なえば、通常の加工方法とほぼ同等の品質のものをエッチング工程を省略した条件で得られることは明らかである。すなわち、乾式研磨方法、換言すれば、乾式のメカノケミカルポリッシングの作用により、前加工の加工精度を維持しながら、物理的な加工で生じた前加工の表面粗さや加工ダメージ層を軽減することにより、次工程であるエッチング（化学的除去加工）の処理を軽減し、加工精度の悪化を抑制し、またはエッチング工程自体を省略することも可能となる。

【図面の簡単な説明】

【図１】　アングルエッチング法を説明する概念図である。（ａ）はウェーハの正面図、（ｂ）はその側面図である。ウェーハのライトエッチングを行なった境界面上の点３のＸ線トポグラフ写真を撮影し、加工ダメージ層の存在を示す黒点のなくなった点４のＸ線トポグラフ写真を撮影する。

【図２】　実施例により得られたウェーハの表面と内層の結晶の状態を示すＸ線トポグラフ観察写真である。（ａ）はウェーハ表面のＸ線トポグラフ観察写真であり、（ｂ）は加工ダメージ層が観察されなくなった深さの層のＸ線トポグラフ観察写真である。

【図３】　比較例１により得られたウェーハの表面と内層の結晶の状態を示すＸ線トポグラフ観察写真である。（ａ）はウェーハ表面のＸ線トポグラフ観察写真であり、（ｂ）は加工ダメージ層が観察されなくなった深さの層のＸ線トポグラフ観察写真である。

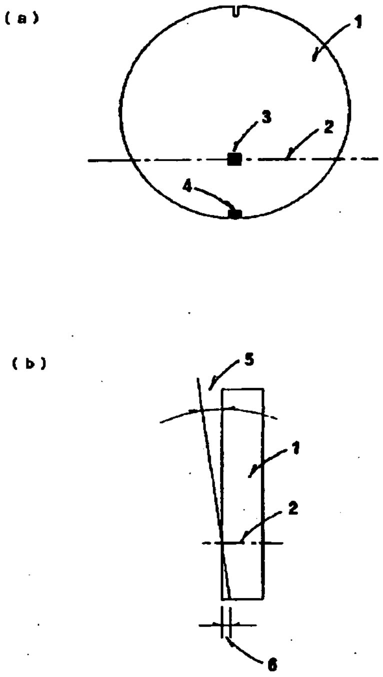
【図４】　比較例２により得られたウェーハの表面と内層の結晶の状態を示すＸ線トポグラフ観察写真である。（ａ）はウェーハ表面のＸ線トポグラフ観察写真であり、（ｂ）は加工ダメージ層が観察されなくなった深さの層のＸ線トポグラフ観察写真である。

【図５】　比較例３により得られたウェーハの表面と内層の結晶の状態を示すＸ線トポグラフ観察写真である。（ａ）はウェーハ表面のＸ線トポグラフ観察写真であり、（ｂ）は加工ダメージ層が観察されなくなった深さの層のＸ線トポグラフ観察写真である。

【符号の説明】

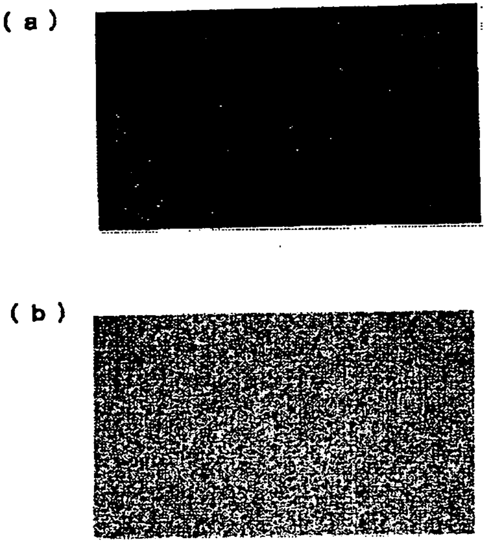
１　ウェーハ　　２　エッチング液の浸漬面
３　ライトエッチングを行なった境界面の観察点
４　加工ダメージ層が観察されなくなる層の観察点
５　エッチング角度　　６　加工ダメージ層の深さ

【図１】



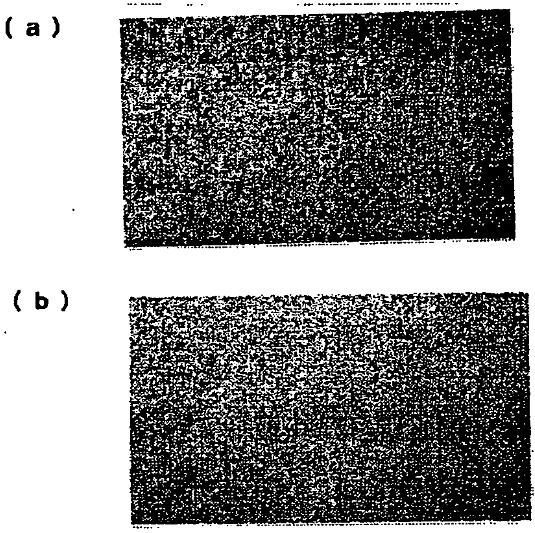
【図３】

図面代用写真



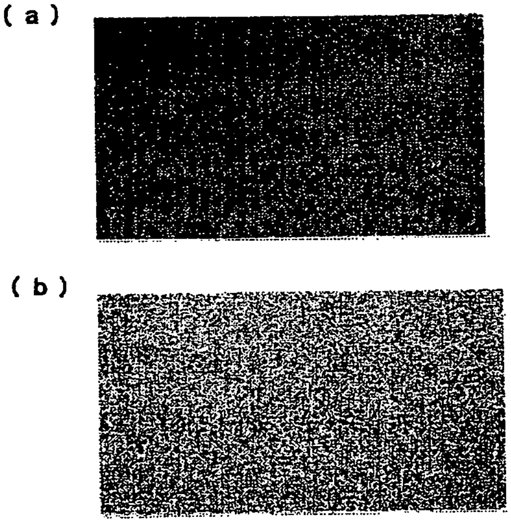
【図２】

図面代用写真



【図４】

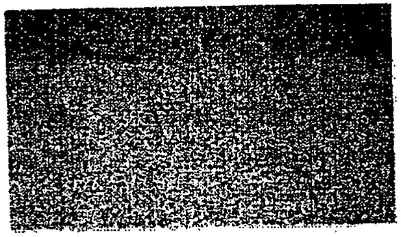
図面代用写真



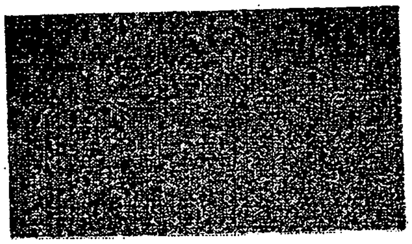
【図５】

図面代用写真

（ａ）



（ｂ）



JAPANESE [JP,11-138422,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

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CLAIMS

[Claim(s)]
[Claim 1] The processing approach of the semiconductor wafer characterized by incorporating the processing process which installs in the processing operating surface of the finishing machine which stuck the scouring pad which fixed the abrasive grain for the wafer which finished the wrapping process in the processing approach of the semiconductor wafer which consists of a series of processes, such as wrapping, etching, and polishing, and performs a press revolution by dry type.
[Claim 2] The processing approach of the semiconductor wafer given in the 1st term of a claim characterized by being at least one of the abrasive grain fines with which the abrasive grain fixed to a scouring pad consists of oxidization silicon, cerium oxide, chromic oxide, a calcium carbonate, a barium carbonate, manganese oxide, and a zirconium dioxide.
[Claim 3] The 1st term of a claim to which the abrasive grain fixed to a scouring pad is characterized by being a 20-micron detailed abrasive grain from the mean particle diameter of 0.01 microns, and the processing approach of a semiconductor wafer given in the 2nd term.
[Claim 4] The 1st term of a claim characterized by for a scouring pad carrying out the laminating of the thing which made a nonwoven fabric, synthetic resin, synthetic-resin foam, synthetic leather, or a textile the shape of a sheet, its kind, or more than it, and making it the shape of a sheet thru/or the processing approach of a semiconductor wafer given in the 3rd term.
[Claim 5] The 1st term of a claim to which a scouring pad is characterized by being the thing of an abrasive grain internal mold thru/or the processing approach of a semiconductor wafer given in the 4th term.
[Claim 6] The 1st term of a claim characterized by the finishing machine which performs dry type processing being a double-sided-type wrapping finishing machine which has a surface plate to vertical both sides thru/or the processing approach of a semiconductor wafer given in the 5th term.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to amelioration of a series of processing approaches of slicing of the ingot of the silicon single crystal which are raw materials, such as IC, LSI, or a VLSI, or the single crystal of a compound system or subsequent ones, i.e., an AZUKATTO wafer, to a mirror plane wafer.
[0002]
[Description of the Prior Art] Conventionally, as for the silicon wafer which gave mirror finish which is raw materials, such as IC, LSI, or a VLSI, or the wafer (it is named a mirror plane wafer generically below) of a compound system, it was common to have been manufactured through a series of following manufacture processes. That is, after performing periphery grinding of single crystal ingots, such as silicon manufactured by the single crystal Czochralski method, for example, orientation flat processing for positioning of crystal orientation is performed, slicing is performed in an inner circumference cutting-edge sow or a wire saw, and an AZUKATTO wafer is obtained. It finishes, after beveling the periphery section according this AZUKATTO wafer to beveling before having uniform thickness and parallelism, flatness, and a certain amount of field granularity by double-sided wrapping processing. An acid or alkali performs etching processing for the obtained RAPPUDO wafer, and mirror finish according a damaged layer to clearance and appropriate after polishing is performed. The mirror plane wafer obtained here must be a thing with the outstanding field granularity and configuration precision.
[0003] In recent years, progress of enlargement of the size of the wafer itself is remarkable to improvement in the process tolerance of a wafer, especially dimensional stability, and coincidence, and improvement in the effectiveness in a processing process, efficiency, or the yield is becoming a very important element from needs, such as a rise of the storage capacity of IC, LSI, or a VLSI, and improvement in productivity, at them. Especially in the case of a silicon wafer, the manufacturing technology of the silicon single crystal ingot used as the raw material improves, and production of the thing of the diameter of 8 inches and the diameter of macrostomia of 12 inches is also coming to be performed. Therefore, in order to process the thing of such a diameter of macrostomia with sufficient productive efficiency, it is changing from the processing process for the conventional diameters of a header.
[0004] Especially in an above-mentioned process, a wrapping process, an etching process, and a polishing process serve as the point. In a wrapping process, using the double-sided wrapping finishing machine which has arranged the metallic surface plate to vertical both sides, for example, press pinching of the wafer is carried out between the vertical surface plate, a surface plate is rotated, and it carries out by supplying the abrasive grain slurry of an alumina system to the processing side. The object of this processing is to remove the variation and the saw mark of thickness by slicing, and obtain uniform thickness, parallelism and flatness, and precise field granularity. According to an operation of an abrasive grain, the field of a wafer is removed little by little and goes, creation of the flat and homogeneous field is carried out, and it goes. In this case, although it is common that the method of processing dozens of wafers simultaneously for improvement in productivity and working capacity is taken, if the aperture of a wafer enlarges

and goes as mentioned above, maintenance of process tolerance will become difficult. In processing, the high stress by operation with a rigid high surface plate and a rigid high abrasive grain originates, the single crystal of a wafer receives distortion, and the processing damage layer which checks the engine performance demanded as a single crystal is formed. Since this processing damage layer is the part which cannot be used at all as a semi-conductor, it must be removed in the following etching process.

[0005] Although the depth of an above-mentioned processing damage layer changes also with wrapping processing conditions, generally it amounts to about ten microns from several microns. The etching technique in a mixed acid or lye is used for clearance of this damage layer. The front face of a wafer is eaten away by chemical operation of an acid or alkali, it is removed, terms and conditions, such as a class of liquid, temperature, and immersion time amount, are adjusted, and thickness required for clearance is adjusted. In this process, although clearance of a processing damage layer can be performed, it breaks down again the configuration acquired at the wrapping process, and worsens parallelism, flatness, etc. Although the mixed acid which mixed an acetic acid, fluoric acid, a nitric acid, etc. suitably as an acid used here is raised and the water solution of a potassium hydroxide can be mentioned as alkali, since comparatively homogeneous etching can be performed, alkali etching is becoming in use in recent years. Moreover, in this process, in order to use deleterious material, such as fluoric acid and a potassium hydroxide, so much, for example, troubles, like a great quantity of loads are applied to that waste water treatment are pointed out. It washes and dries, and through sorting by inspection, the wafer after etching moves to the following polishing process, in order to acquire a final mirror plane.

[0006] In a polishing process, the configuration precision which got worse in the etching process of the preceding paragraph is corrected, and although it is processed for the purpose of acquiring a very precise mirror plane while obtaining uniform thickness, and the outstanding parallelism and flatness, the polishing machine which has the surface plate which stuck the polishing pad with which a finishing machine consists of a nonwoven fabric etc. is used. Although polishing generally uses an one side type with a lower lapping plate, at primary polishing for sending especially configuration precision, the double-sided type thing which stuck the nonwoven fabric of eye ** on the vertical surface plate a little coarsely is used, and the one side type thing which stuck the nonwoven fabric of a suede tone on the lower lapping plate is used at the last polishing process. although the reason using a nonwoven fabric be for acquire a mirror plane , correct the configuration worsened by etching , without give a processing damage , its place which undertake to a compound operation with a clearance operation accord to an abrasive grain a chemical operation (it depend for a reaction rate on temperature) of alkali water solutions , such as a potassium hydroxide (KOH) , and the end of superfines , such as oxidation silicon which the water solution be made to distribute , by measure the local temperature rise of the wafer by strong frictional force be large . Although it is processing called so-called mechanochemical polishing, a precise mirror plane can be acquired without making the processing damage layer which produces the elastic resultant made according to a chemical etching operation in physical processing of wrapping etc. by removing with an abrasive grain after [softer than a wafer (workpiece)] superfines generate. Since it is 1/10 or less loose clearance rate of wrapping, the more this working speed has little effectiveness of configuration correction and its depth (processing damage layer) which should be removed is deep, the more it has the problem whose floor to floor time increases-like proportionally.

[0007] Although it was common to have been manufactured through a series of above-mentioned manufacture processes as for the mirror plane wafer as stated above By passing through that wrapping process of the first half in this process It says [that the processing damage layer which cannot be used as a semi-conductor raw material is formed], And the etching process for removing the processing damage layer is needed. It sees [it not only worsens the configuration precision of a wafer by that, but / the etching process] in work environment and is not desirable, and the load exerted on the waste water treatment equipment is also very expensive, And it was pointed out as a trouble with there being little effectiveness of the configuration correction in a polishing process, and big floor to floor time being also long. As one of the solution approaches of such a trouble, there is processing by the grinder (cup-like grinding stone) which embedded for example, the diamond detailed abrasive grain as bonded abrasive. As compared with the wrapping technique using a loose grain, the depth of a processing damage layer becomes about 1/10, therefore processing by bonded abrasive, i.e., a grinder, is effective in lessening the amount of clearances in the etching process which is degree process, and it can expect to control aggravation of the process tolerance by etching. However, since it is the linear trace in which the problem of curvature tends to come out of two or more sheets the top where productive efficiency is low as compared with wrapping processing based on double-sided simultaneous processing, and processing marks have directivity since it is moreover based on finishing of every one side by processing of single wafer processing in this grinder processing, when there is a deep striation especially, it has the danger of expanding it further at the following etching process. namely, the edge-of-a-blade management technique of a diamond abrasive grain — very — difficulty — at a present stage, it has not resulted in utilization yet highly. Moreover, although the approach of wrapping by using a plate-like grinding stone surface plate instead of a wrapping surface plate was also proposed (JP,6-71708,B), it was hard to say this to having the same trouble as ****, and coincidence as the approach that the maintenance of the configuration (flatness, parallelism) of the field of a surface plate is difficult, and perfect. Furthermore, although making fine abrasive grain grain size in the polish liquid used in a wrapping process was also considered as a cure, when this was made into a grain size finer than FO of No. 1500, it becomes easy to generate a scratch (line blemish) on a wafer front face, and was not practical.

[0008]

[Problem(s) to be Solved by the Invention] In the general wrapping process in the actual condition, although the slurry containing FO abrasive grain of the abrasive grain yarn count of No. 1200 (mean particle diameter: 7-8 microns) is used as working liquid using a cast iron surface plate, the surface roughness obtained by this is about 0.15 microns in Ra, and TTV (total chic NESUBARIESHON) is about 1.0 microns again. The depth of a processing damage layer serves as about 10-20 microns of profiles simultaneously. That is, thereby, although this about 10-20-micron processing damage layer is removed in the etching process after wrapping, although surface roughness improves, TTV gets worse to about 1-3 microns. this invention person etc. comes to solve the following things, as a result of inquiring wholeheartedly in view of this actual condition. That is, in order to use a detailed abrasive grain with high rigid high wrapping surface plate and rigid degree of hardness extremely, high stress acts on a wafer front face, the single crystal structural failure is performed, and a processing damage layer is made to generate inside a crystal in a wrapping process. Therefore, although mitigating this stress will reduce the depth of a processing damage layer, floor to floor time will be extended and it does not become a problem solving by the approach of only mitigating stress physically, for example, the approach of making the processing pressure force low.

[0009] this invention person etc. is the approach of not breaking down the already acquired configuration precision, after performing the usual wrapping processing. The result of having examined the approach of performing only clearance of a processing damage layer, If processing by this abrasive cloth is performed under a certain certain conditions using the abrasive cloth which made what stuck the nonwoven fabric etc. on the surface plate fix the detailed abrasive grain for polish after the usual wrapping processing The rigidity of surface plates, such as cast iron, is eased, and the header this invention approach is completed for a processing damage layer being removable, without breaking down the configuration precision of the already acquired field greatly. The object of this invention tends to offer the processing process of a series of mirror plane wafers of having been improved for lessening the amount of clearances by mitigating the abbreviation of an etching process which has big effect on configuration precision, such as TTV, especially as above-mentioned, or the conditions in an etching process.

[0010]

[Means for Solving the Problem] In the processing approach of the semiconductor wafer which consists of a series of processes, such as wrapping, etching, and polishing, the above-mentioned object is installed in the processing operating surface of the finishing machine which stuck the scouring pad which fixed the abrasive grain for the wafer which finished the wrapping process, and can be attained by the processing approach of the semiconductor wafer characterized by incorporating the processing process which performs a press revolution by dry type. It is desirable that it is at least one of the abrasive grain fines with which the abrasive grain fixed to a scouring pad consists of oxidization silicon, cerium oxide, chromic oxide, a calcium carbonate, a barium carbonate, manganese oxide, and a zirconium dioxide. And as for the grain size of the abrasive grain, an about 20-micron thing is selectively used from the mean particle diameter of 0.01 microns. Moreover, what carried out the laminating of a kind or more than it, and made a thing, it, etc. which made a nonwoven fabric, synthetic resin, synthetic-resin foam, synthetic leather, or a textile the shape of a sheet the shape of a sheet as a raw material for scouring pads is used. It is good also as a thing of an abrasive grain internal mold, and abrasive grain impalpable powder is added and it may be [abrasive grain impalpable powder is supplied at the time of processing, and] made to make an abrasive grain a pad into the production process of pads, such as this, semipermanent. Furthermore, you may make it combine these both. Although definition cannot be received and the wrapping finishing machine of one side or both sides, the grinder of both head forms, etc. can be used for arbitration especially as equipment which performs this processing, it is desirable to use especially for vertical both sides the wrapping finishing machine which has a surface plate.

[0011]

[Embodiment of the Invention] The wafer as used in the field of this invention carries out slicing of the ingot of compound semiconductor single crystals, such as a silicon single crystal, or a gallium/arsenic, and makes it with the wafer of mirror finish through many above-mentioned processes. In a subsequent device process, the chip used as the bases, such as IC and LSI, is made to the wafer which gave mirror finish, and it goes a chip. Since the circuit complicated and detailed, and precise is written in the wafer side in this device process, in the wafer process of that preceding paragraph story, the fields which write in at least must be very precise field granularity and a thing with configuration precision. The numeric value generally required of a mirror plane wafer is about 0.0002 microns of field granularity Ra by the side of 720 microns in 1.0 micron or less of TTV(s), and thickness, and a mirror plane. although the RAPPUDO wafer which corrected the variation in the thickness of a wafer according to the usual wrapping process first, and had desirable parallelism, flatness, and field granularity in this invention approach is obtained — a RAPPUDO wafer here — a profile — it has a numeric value like a degree. Namely, thickness: It is 760 microns, less than [TTV:1.0 micron], and about 0.15 microns of field granularity:Ra, and has an about 10-20-micron processing damage layer in the both sides.

[0012] These all processing damage layers or its part is effectively removable what is ground by dry type, without supplying polish liquid with the scouring pad which fixed the abrasive grain as used in the field of [a RAPPUDO wafer with this processing damage layer] this invention (it is henceforth indicated as dry type polish). A scouring pad here means the thing like a less or equal. That is, the thing used as the base material can mention the synthetic leather which carried out impregnation processing of the synthetic resin, or the thing which formed these raw materials into laminating compound a kind or more than it to the foam of a nonwoven fabric, synthetic resin, or synthetic resin which prepared the synthetic fiber and the natural fiber the textiles which **(ed) or ******(ed), the span tex which similarly used the synthetic fiber and the natural fiber, and the shape of the shape of felt, and suede, a textile, or a nonwoven fabric. It can use by making raw materials, such as this, into the shape of a sheet with the uniform thickness of about 0.2-several mm. When sheets, such as this, are seen in micro, since that front face is void structure or it has the microrelief by the confounding of fiber, if abrasive grain powder is given to homogeneity, abrasive grain impalpable powder will enter the gap of this void or fiber, and will be fixed to this part. If resin treatment is lightly performed in this condition, the condition of that immobilization will become still firmer. Moreover, if an abrasive grain is supplied between them in the phase of processing when the amount of abrasive grains fixed to the front face is insufficient or run short by omission etc., it is possible to compensate the lack. When it was the thing of the mold with which the above-mentioned scouring pad carried out internal [of the powder of a detailed abrasive grain] to the interior at the time of manufacture of the base material, or processing, the effectiveness and stability of above-mentioned dry type polish should be excelled more.

[0013] Moreover, although especially the class of detailed abrasive grain powder used here does not receive definition, it is desirable in the case of the thing which has a degree of hardness lower than a worked object or a comparable thing, and the silicon wafer in which a worked object specifically has the numeric value of 8 with new Mohs hardness to be selected from an EQC or the oxidization silicon of the degree of hardness not more than it, cerium oxide, chromic oxide, manganese oxide, a calcium carbonate, a barium carbonate, a zirconium dioxide, etc. so that stress especially strong against a wafer side may not be given. Moreover, as for the grain size, it is desirable that it is what does not worsen the field granularity obtained by wrapping which is the before process, and it is desirable that it is what specifically has the mean particle diameter of about 0.01-20 microns.

[0014] A before process is wrapping processing, since it is in clearance of the processing damage layer generated to both sides of the wafer produced in double-sided wrapping processing as the object of this dry-type polish process was the above-mentioned, the above-mentioned abrasive cloth sticks on the surface plate side of a finishing machine, precision is good in actual processing, and in order to process it efficiently, also as for a finishing machine, it is desirable that it is processing by the double-sided method as well as a before process. It is desirable to specifically stick and process said abrasive cloth on the field of the double-sided finishing machine which has a surface plate to vertical both sides. Pressing a vertical surface plate by the fixed pressure without pinching a RAPPUDO wafer and supplying polish liquid in processing, between the surface plates of the double-sided finishing machine which stuck said abrasive cloth on vertical both sides, you make it rotate by motion of a revolution, the carrier plate with which a RAPPUDO wafer also grasps it simultaneously and a sun gear, and an internal gear, and it is processed in those operations. Since the abrasive grain itself is elasticity as compared with the alumina and FO abrasive grain which were used at the wrapping process, to the RAPPUDO wafer which is a workpiece, stress is low in that cushioning properties are in abrasive cloth as compared with a powerful rigid cast iron surface plate etc., and a list, and it is hard to give a damage to them. Therefore, without worsening the level of TTV obtained at the wrapping process by performing this processing, most processing damage layers can be removed and, moreover, working speed is several times larger as compared with processing with wet.

[0015] Subsequently, although the wafer obtained here is processed at the etching process which is the following process Since the depth of a processing damage layer is stopped by about 2-3 microns and surface roughness Ra is also improved by about 0.0005 microns, The amount of clearances by etching can be mitigated from conventional 20-30 microns to about 5 microns, and the amount of aggravation of TTV by the conventional etching also becomes possible [mitigating to 0.5 microns or less] from 1-3 microns.

[0016] Since the amount of aggravation of TTV by etching is greatly mitigated like ****, the load which the configuration correction in the polishing process which is degree process takes decreases, and the time amount which processing takes can be shortened by leaps and bounds. It makes it possible to specifically shorten greatly conventionally the time amount which primary polishing which made it the key objective to correct the configuration precision which got worse in the etching process, and to obtain uniform thickness, the outstanding parallelism, and flatness takes.

[0017]

[Working Example(s) and Comparative Example(s)] Although an example is given below and this invention approach is explained concretely, especially this does not receive definition. Moreover, the approach of the equipment which processes the AZUKATTO silicon wafer of 200mm size in the following examples and examples of a comparison, and was used, consumable goods, processing conditions, and an assessment experiment is as being shown below.

<Wrapping process> finishing machine: Double side lapping machine 24B-5 L type (product made from speed FAMUJAPAN)

surface plate outer-diameter: — 1,592mm surface plate bore: — 554mm surface plate thickness:

— 70mm working liquid: — FO#1200 and 30 % of the weight slurry work-piece:200mm AZUKATTO silicon wafer processing condition:top board rotational frequency;-10rpm (clockwise rotation)
Lower lapping plate rotational frequency; 40rpm (counterclockwise rotation)
Sun-gear rotational frequency; 18rpm (counterclockwise rotation)
internal gear rotational frequency; — 10rpm working liquid flow rate; — a part for 1000mL/ amount of processing clearances; — 80-micrometer <dry type polish process> finishing machine: — double side lapping machine 24B-5 L type (product made from speed FAMUJAPAN)
surface plate appearance: — 1,592mm surface plate bore: — 554mm processing pressure force: — number of 35kPa top board revolutions: -10rpm (circumference of a clockwise rotation)
number of lower lapping plate revolutions: — number of 40rpm sun-gear revolutions: — 18rpm (circumference of a counterclockwise rotation)
number of internal gear rotations: — 10rpm pad material: — SUBA800 (Rodel Nitta CO. make) — the barium carbonate of 0.1 microns of mean diameters — a semipermanent condition — carrying out — amount:of activity processing clearances 50 micron (25 microns of one side)
<Etching process> liquid presentation: 1(fluoric acid)/1(nitric acid)/8 (acetic acid)
Immersion time amount: After the liquid immersion during 1 minute, Lynn Synge <polishing process> finishing machine:polishing equipment 59 SPAW-II during 15 minutes (product made from speed FAMUJAPAN)
surface plate diameter: — 1,504mm processing pressure force: — primary polish; — 15kPa Secondary 4th [-]; Ten or less kPas rotating speed : 40rpm working liquid flow rate: — primary 3rd [-]; — 6 L/min (circulation) 4th; — 6 L/min pad material: — primary; — SUBA800 secondary - 3rd; 4004th SUBA; — the wafer sampled from each processing phase used as the object for the poly tex <assessment experiment approach> assessment It built vertically, and from the soffit, it was gradually immersed in the light etching reagent, the sample was created by the approach (angle-type etching) of etching aslant at the loose include angle 5 like drawing 1 according to the difference of time amount (progress), and the condition (extent and the depth of a processing damage layer) of a crystal was investigated. Drawing 1 (a) is the front view of a wafer 1, and drawing 1 (b) is the side elevation. A broken line 2 shows the immersion side of a light etching reagent. The photograph by the X-ray topogrph method observes and investigates the condition of a processing damage layer, and many sunspots are observed, so that the damage by processing is strong. The X-ray topogrph photograph of the wafer front face which is not etched and each etched part was taken, the point that a sunspot was no longer observed was searched for, and it asked for the depth 6 of the part, i.e., the depth of a damage layer, by count from the etching include angle.

[0018] Wrapping processing of what carried out the **** ring of the periphery of the AZUKATTO wafer cut from the example ingot was carried out further, and the obtained RAPPUDO wafer was used as the start ingredient. Dry type polish processing was performed for this RAPPUDO wafer ingredient on condition that the ****. The wafer after polish processing obtained here was made into the charge of a sample offering, and it observed by the above-mentioned assessment experiment approach. Drawing 2 was an X-ray topogrph photograph in which the result is shown, when the photograph of drawing 2 (b) in which it is the front face which carried out dry type polish, and the condition of a part with a depth of about 5 microns is shown from the front face was compared, the condition hardly changed drawing 2 (a), but it turned out that the depth of a processing damage layer is 5 microns or less.

[0019] Wrapping processing of what carried out the **** ring of the periphery of the AZUKATTO wafer cut from example of comparison 1 ingot was carried out, the obtained RAPPUDO wafer was made into the charge of a sample offering, and it observed by the above-mentioned assessment experiment approach. drawing 3 was an X-ray topogrph photograph in which the result is shown, and from photograph drawing 3 (a) of the wrapped front face, although it was observed that there are a processing damage and a crack clearly, it was observed that the sunspot of an X-ray topogrph decreases gradually and the front face to a depth of about 20 microns reaches about 1 law in the depth (photograph of drawing 3 (b)) which is 20 microns. That is, in the usual RAPPUDO wafer, it turned out that the depth of the processing damage layer is about 20 microns.

[0020] Wrapping processing of what carried out the **** ring of the periphery of the AZUKATTO wafer cut from example of comparison 2 ingot was carried out, and what etched further on condition that the **** was made into the charge of a sample offering. According to the above-mentioned assessment experiment approach, it observed about this charge of a sample offering. Drawing 4 was an X-ray topogrph photograph in which the result is shown, when the photograph of drawing 4 (b) in which the etched front face is shown and a condition with a depth of about 5 microns is shown from the front face was compared, the condition hardly changed drawing 4 (a), therefore in the case of the usual etched wafer, it turned out that there is nothing practical as for the depth of a processing damage layer.

[0021] What performed polishing for the charge of a sample offering after the dry type polish obtained in the example of comparison 3 example further on condition that the **** was made into the charge of a sample offering. According to the above-mentioned assessment experiment approach, it observed about this charge of a sample offering. It turned out that drawing 5 is an X-ray topogrph photograph in which the result is shown, and there is also no depth of the processing damage layer at the time of performing polishing processing after the condition's having hardly changed, therefore performing dry type polish of this invention practical if drawing 5 (a) compares the photograph of drawing 5 (b) in which the etched front face is shown and a condition with a depth of about 5 microns is shown from the front face.

[0022]

[Effect of the Invention] If a semiconductor wafer is processed by the approach of becoming this invention a passage clear from the above result, it is clear to obtain the thing of quality almost equivalent to the usual processing approach on the conditions which skipped the etching process. That is, it also becomes possible to mitigate processing of etching (chemical removal processing) which is degree process the dry type polish approach and by mitigating the surface roughness and the processing damage layer of processing before being generated in physical processing, and to control aggravation of process tolerance, or to skip the etching process itself according to an operation of dry-type mechanochemical polishing, maintaining the process tolerance of front processing, if it puts in another way.

[Translation done.]

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TECHNICAL FIELD

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PRIOR ART

[Description of the Prior Art] Conventionally, as for the silicon wafer which gave mirror finish which is raw materials, such as IC, LSI, or a VLSI, or the wafer (it is named a mirror plane wafer generically below) of a compound system, it was common to have been manufactured through a series of following manufacture processes. That is, after performing periphery grinding of single crystal ingots, such as silicon manufactured by the single crystal Czochralski method, for example, orientation flat processing for positioning of crystal orientation is performed, slicing is performed in an inner circumference cutting-edge sow or a wire saw, and an AZUKATTO wafer is obtained. It finishes, after beveling the periphery section according this AZUKATTO wafer to beveling before having uniform thickness and parallelism, flatness, and a certain amount of field granularity by double-sided wrapping processing. An acid or alkali performs etching processing for the obtained RAPPUDO wafer, and mirror finish according a damaged layer to clearance and appropriate after polishing is performed. The mirror plane wafer obtained here must be a thing with the outstanding field granularity and configuration precision.
[0003] In recent years, progress of enlargement of the size of the wafer itself is remarkable to improvement in the process tolerance of a wafer, especially dimensional stability, and coincidence, and improvement in the effectiveness in a processing process, efficiency, or the yield is becoming a very important element from needs, such as a rise of the storage capacity of IC, LSI, or a VLSI, and improvement in productivity, at them. Especially in the case of a silicon wafer, the manufacturing technology of the silicon single crystal ingot used as the raw material improves, and production of the thing of the diameter of 8 inches and the diameter of macrostomia of 12 inches is also coming to be performed. Therefore, in order to process the thing of such a diameter of macrostomia with sufficient productive efficiency, it is changing from the processing process for the conventional diameters of a header.
[0004] Especially in an above-mentioned process, a wrapping process, an etching process, and a polishing process serve as the point. In a wrapping process, using the double-sided wrapping finishing machine which has arranged the metallic surface plate to vertical both sides, for example, press pinching of the wafer is carried out between the vertical surface plate, a surface plate is rotated, and it carries out by supplying the abrasive grain slurry of an alumina system to the processing side. The object of this processing is to remove the variation and the saw mark of thickness by slicing, and obtain uniform thickness, parallelism and flatness, and precise field granularity. According to an operation of an abrasive grain, the field of a wafer is removed little by little and goes, creation of the flat and homogeneous field is carried out, and it goes. In this case, although it is common that the method of processing dozens of wafers simultaneously for improvement in productivity and working capacity is taken, if the aperture of a wafer enlarges and goes as mentioned above, maintenance of process tolerance will become difficult. In processing, the high stress by operation with a rigid high surface plate and a rigid high abrasive grain originates, the single crystal of a wafer receives distortion, and the processing damage layer which checks the engine performance demanded as a single crystal is formed. Since this processing damage layer is the part which cannot be used at all as a semi-conductor, it must be removed in the following etching process.
[0005] Although the depth of an above-mentioned processing damage layer changes also with

wrapping processing conditions, generally it amounts to about ten microns from several microns. The etching technique in a mixed acid or lye is used for clearance of this damage layer. The front face of a wafer is eaten away by chemical operation of an acid or alkali, it is removed, terms and conditions, such as a class of liquid, temperature, and immersion time amount, are adjusted, and thickness required for clearance is adjusted. In this process, although clearance of a processing damage layer can be performed, it breaks down again the configuration acquired at the wrapping process, and worsens parallelism, flatness, etc. Although the mixed acid which mixed an acetic acid, fluoric acid, a nitric acid, etc. suitably as an acid used here is raised and the water solution of a potassium hydroxide can be mentioned as alkali, since comparatively homogeneous etching can be performed, alkali etching is becoming in use in recent years. Moreover, in this process, in order to use deleterious material, such as fluoric acid and a potassium hydroxide, so much, for example, troubles, like a great quantity of loads are applied to that waste water treatment are pointed out. It washes and dries, and through sorting by inspection, the wafer after etching moves to the following polishing process, in order to acquire a final mirror plane.

[0006] In a polishing process, the configuration precision which got worse in the etching process of the preceding paragraph is corrected, and although it is processed for the purpose of acquiring a very precise mirror plane while obtaining uniform thickness, and the outstanding parallelism and flatness, the polishing machine which has the surface plate which stuck the polishing pad with which a finishing machine consists of a nonwoven fabric etc. is used. Although polishing generally uses an one side type with a lower lapping plate, at primary polishing for sending especially configuration precision, the double-sided type thing which stuck the nonwoven fabric of eye ** on the vertical surface plate a little coarsely is used, and the one side type thing which stuck the nonwoven fabric of a suede tone on the lower lapping plate is used at the last polishing process. although the reason using a nonwoven fabric be for acquire a mirror plane , correct the configuration worsened by etching , without give a processing damage , its place which undertake to a compound operation with a clearance operation accord to an abrasive grain a chemical operation (it depend for a reaction rate on temperature) of alkali water solutions , such as a potassium hydroxide (KOH) , and the end of superfines , such as oxidation silicon which the water solution be made to distribute , by measure the local temperature rise of the wafer by strong frictional force be large . Although it is processing called so-called mechanochemical polishing, a precise mirror plane can be acquired without making the processing damage layer which produces the elastic resultant made according to a chemical etching operation in physical processing of wrapping etc. by removing with an abrasive grain after [softer than a wafer (workpiece)] superfines generate. Since it is 1/10 or less loose clearance rate of wrapping, the more this working speed has little effectiveness of configuration correction and its depth (processing damage layer) which should be removed is deep, the more it has the problem whose floor to floor time increases-like proportionally.

[0007] Although it was common to have been manufactured through a series of above-mentioned manufacture processes as for the mirror plane wafer as stated above By passing through that wrapping process of the first half in this process It says [that the processing damage layer which cannot be used as a semi-conductor raw material is formed], And the etching process for removing the processing damage layer is needed. It sees [it not only worsens the configuration precision of a wafer by that, but / the etching process] in work environment and is not desirable, and the load exerted on the waste water treatment equipment is also very expensive, And it was pointed out as a trouble with there being little effectiveness of the configuration correction in a polishing process, and big floor to floor time being also long. As one of the solution approaches of such a trouble, there is processing by the grinder (cup-like grinding stone) which embedded for example, the diamond detailed abrasive grain as bonded abrasive. As compared with the wrapping technique using a loose grain, the depth of a processing damage layer becomes about 1/10, therefore processing by bonded abrasive, i.e., a grinder, is effective in lessening the amount of clearances in the etching process which is degree process, and it can expect to control aggravation of the process tolerance by etching. However, since it is the linear trace in which the problem of curvature tends to come out of two or more sheets the top where productive efficiency is low as compared with wrapping processing based on double-sided simultaneous processing, and processing marks have directivity since it is moreover based on finishing of every one side by processing of single wafer processing in this grinder processing, when there is a deep striation especially, it has the danger of expanding it further at the following etching process. namely, the edge-of-a-blade management technique of a diamond abrasive grain — very — difficulty — at a present stage, it has not resulted in utilization yet highly. Moreover, although the approach of wrapping by using a plate-like grinding stone surface plate instead of a wrapping surface plate was also proposed (JP,6-71708,B), it was hard to say this to having the same trouble as ****, and coincidence as the approach that the maintenance of the configuration (flatness, parallelism) of the field of a surface plate is difficult, and perfect. Furthermore, although making fine abrasive grain grain size in the polish liquid used in a wrapping process was also considered as a cure, when this was made into a grain size finer than FO of No. 1500, it becomes easy to generate a scratch (line blemish) on a wafer front face, and was not practical.

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EFFECT OF THE INVENTION

[Effect of the Invention] If a semiconductor wafer is processed by the approach of becoming this invention a passage clear from the above result, it is clear to obtain the thing of quality almost equivalent to the usual processing approach on the conditions which skipped the etching process. That is, it also becomes possible to mitigate processing of etching (chemical removal processing) which is degree process the dry type polish approach and by mitigating the surface roughness and the processing damage layer of processing before being generated in physical processing, and to control aggravation of process tolerance, or to skip the etching process itself according to an operation of dry-type mechanochemical polishing, maintaining the process tolerance of front processing, if it puts in another way.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] In the general wrapping process in the actual condition, although the slurry containing FO abrasive grain of the abrasive grain yarn count of No. 1200 (mean particle diameter: 7-8 microns) is used as working liquid using a cast iron surface plate, the surface roughness obtained by this is about 0.15 microns in Ra, and TTV (total chic NESUBARIESHON) is about 1.0 microns again. The depth of a processing damage layer serves as about 10-20 microns of profiles simultaneously. That is, thereby, although this about 10-20-micron processing damage layer is removed in the etching process after wrapping, although surface roughness improves, TTV gets worse to about 1-3 microns. this invention person etc. comes to solve the following things, as a result of inquiring wholeheartedly in view of this actual condition. That is, in order to use a detailed abrasive grain with high rigid high wrapping surface plate and rigid degree of hardness extremely, high stress acts on a wafer front face, the single crystal structural failure is performed, and a processing damage layer is made to generate inside a crystal in a wrapping process. Therefore, although mitigating this stress will reduce the depth of a processing damage layer, floor to floor time will be extended and it does not become a problem solving by the approach of only mitigating stress physically, for example, the approach of making the processing pressure force low.
[0009] this invention person etc. is the approach of not breaking down the already acquired configuration precision, after performing the usual wrapping processing. The result of having examined the approach of performing only clearance of a processing damage layer, If processing by this abrasive cloth is performed under a certain certain conditions using the abrasive cloth which made what stuck the nonwoven fabric etc. on the surface plate fix the detailed abrasive grain for polish after the usual wrapping processing The rigidity of surface plates, such as cast iron, is eased, and the header this invention approach is completed for a processing damage layer being removable, without breaking down the configuration precision of the already acquired field greatly. The object of this invention tends to offer the processing process of a series of mirror plane wafers of having been improved for lessening the amount of clearances by mitigating the abbreviation of an etching process which has big effect on configuration precision, such as TTV, especially as above-mentioned, or the conditions in an etching process.

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MEANS

[Means for Solving the Problem] In the processing approach of the semiconductor wafer which consists of a series of processes, such as wrapping, etching, and polishing, the above-mentioned object is installed in the processing operating surface of the finishing machine which stuck the scouring pad which fixed the abrasive grain for the wafer which finished the wrapping process, and can be attained by the processing approach of the semiconductor wafer characterized by incorporating the processing process which performs a press revolution by dry type. It is desirable that it is at least one of the abrasive grain fines with which the abrasive grain fixed to a scouring pad consists of oxidization silicon, cerium oxide, chromic oxide, a calcium carbonate, a barium carbonate, manganese oxide, and a zirconium dioxide. And as for the grain size of the abrasive grain, an about 20-micron thing is selectively used from the mean particle diameter of 0.01 microns. Moreover, what carried out the laminating of a kind or more than it, and made a thing, it, etc. which made a nonwoven fabric, synthetic resin, synthetic-resin foam, synthetic leather, or a textile the shape of a sheet the shape of a sheet as a raw material for scouring pads is used. It is good also as a thing of an abrasive grain internal mold, and abrasive grain impalpable powder is added and it may be [abrasive grain impalpable powder is supplied at the time of processing, and] made to make an abrasive grain a pad into the production process of pads, such as this, semipermanent. Furthermore, you may make it combine these both. Although definition cannot be received and the wrapping finishing machine of one side or both sides, the grinder of both head forms, etc. can be used for arbitration especially as equipment which performs this processing, it is desirable to use especially for vertical both sides the wrapping finishing machine which has a surface plate.

[0011]

[Embodiment of the Invention] The wafer as used in the field of this invention carries out slicing of the ingot of compound semiconductor single crystals, such as a silicon single crystal, or a gallium/arsenic, and makes it with the wafer of mirror finish through many above-mentioned processes. In a subsequent device process, the chip used as the bases, such as IC and LSI, is made to the wafer which gave mirror finish, and it goes a chip. Since the circuit complicated and detailed, and precise is written in the wafer side in this device process, in the wafer process of that preceding paragraph story, the fields which write in at least must be very precise field granularity and a thing with configuration precision. The numeric value generally required of a mirror plane wafer is about 0.0002 microns of field granularity Ra by the side of 720 microns in 1.0 micron or less of TTV(s), and thickness, and a mirror plane. although the RAPPUDO wafer which corrected the variation in the thickness of a wafer according to the usual wrapping process first, and had desirable parallelism, flatness, and field granularity in this invention approach is obtained — a RAPPUDO wafer here — a profile — it has a numeric value like a degree. Namely, thickness: It is 760 microns, less than [TTV:1.0 micron], and about 0.15 microns of field granularity:Ra, and has an about 10-20-micron processing damage layer in the both sides.

[0012] These all processing damage layers or its part is effectively removable what is ground by dry type, without supplying polish liquid with the scouring pad which fixed the abrasive grain as used in the field of [a RAPPUDO wafer with this processing damage layer] this invention (it is henceforth indicated as dry type polish). A scouring pad here means the thing like a less or equal. That is, the thing used as the base material can mention the synthetic leather which carried out impregnation processing of the synthetic resin, or the thing which formed these raw materials into laminating compound a kind or more than it to the foam of a nonwoven fabric, synthetic resin, or synthetic resin which prepared the synthetic fiber and the natural fiber the textiles which **(ed) or ******(ed), the span tex which similarly used the synthetic fiber and the natural fiber, and the shape of the shape of felt, and suede, a textile, or a nonwoven fabric. It can use by making raw materials, such as this, into the shape of a sheet with the uniform thickness of about 0.2-several mm. When sheets, such as this, are seen in micro, since that front face is void structure or it has the microrelief by the confounding of fiber, if abrasive grain powder is given to homogeneity, abrasive grain impalpable powder will enter the gap of this void or fiber, and will be fixed to this part. If resin treatment is lightly performed in this condition, the condition of that immobilization will become still firmer. Moreover, if an abrasive grain is supplied between them in the phase of processing when the amount of abrasive grains fixed to the front face is insufficient or run short by omission etc., it is possible to compensate the lack. When it was the thing of the mold with which the above-mentioned scouring pad carried out internal [of the powder of a detailed abrasive grain] to the interior at the time of manufacture of the base material, or processing, the effectiveness and stability of above-mentioned dry type polish should be excelled more.

[0013] Moreover, although especially the class of detailed abrasive grain powder used here does not receive definition, it is desirable in the case of the thing which has a degree of hardness lower than a worked object or a comparable thing, and the silicon wafer in which a worked object specifically has the numeric value of 8 with new Mohs hardness to be selected from an EQC or the oxidization silicon of the degree of hardness not more than it, cerium oxide, chromic oxide, manganese oxide, a calcium carbonate, a barium carbonate, a zirconium dioxide, etc. so that stress especially strong against a wafer side may not be given. Moreover, as for the grain size, it is desirable that it is what does not worsen the field granularity obtained by wrapping which is the before process, and it is desirable that it is what specifically has the mean particle diameter of about 0.01-20 microns.

[0014] A before process is wrapping processing, since it is in clearance of the processing damage layer generated to both sides of the wafer produced in double-sided wrapping processing as the object of this dry-type polish process was the above-mentioned, the above-mentioned abrasive cloth sticks on the surface plate side of a finishing machine, precision is good in actual processing, and in order to process it efficiently, also as for a finishing machine, it is desirable that it is processing by the double-sided method as well as a before process. It is desirable to specifically stick and process said abrasive cloth on the field of the double-sided finishing machine which has a surface plate to vertical both sides. Pressing a vertical surface plate by the fixed pressure without pinching a RAPPUDO wafer and supplying polish liquid in processing, between the surface plates of the double-sided finishing machine which stuck said abrasive cloth on vertical both sides, you make it rotate by motion of a revolution, the carrier plate with which a RAPPUDO wafer also grasps it simultaneously and a sun gear, and an internal gear, and it is processed in those operations. Since the abrasive grain itself is elasticity as compared with the alumina and FO abrasive grain which were used at the wrapping process, to the RAPPUDO wafer which is a workpiece, stress is low in that cushioning properties are in abrasive cloth as compared with a powerful rigid cast iron surface plate etc., and a list, and it is hard to give a damage to them. Therefore, without worsening the level of TTV obtained at the wrapping process by performing this processing, most processing damage layers can be removed and, moreover, working speed is several times larger as compared with processing with wet.

[0015] Subsequently, although the wafer obtained here is processed at the etching process which is the following process Since the depth of a processing damage layer is stopped by about 2-3 microns and surface roughness Ra is also improved by about 0.0005 microns, The amount of clearances by etching can be mitigated from conventional 20-30 microns to about 5 microns, and the amount of aggravation of TTV by the conventional etching also becomes possible [mitigating to 0.5 microns or less] from 1-3 microns.

[0016] Since the amount of aggravation of TTV by etching is greatly mitigated like ****, the load which the configuration correction in the polishing process which is degree process takes decreases, and the time amount which processing takes can be shortened by leaps and bounds. It makes it possible to specifically shorten greatly conventionally the time amount which primary polishing which made it the key objective to correct the configuration precision which got worse in the etching process, and to obtain uniform thickness, the outstanding parallelism, and flatness takes.

[0017]

[Working Example(s) and Comparative Example(s)] Although an example is given below and this invention approach is explained concretely, especially this does not receive definition. Moreover, the approach of the equipment which processes the AZUKATTO silicon wafer of 200mm size in the following examples and examples of a comparison, and was used, consumable goods, processing conditions, and an assessment experiment is as being shown below.
<Wrapping process> finishing machine: Double side lapping machine 24B-5 L type (product made from speed FAMUJAPAN)
surface plate outer-diameter: — 1,592mm surface plate bore: — 554mm surface plate thickness: — 70mm working liquid: — FO#1200 and 30 % of the weight slurry work-piece:200mm AZUKATTO silicon wafer processing condition:top board rotational frequency;-10rpm (clockwise rotation)
Lower lapping plate rotational frequency; 40rpm (counterclockwise rotation)
Sun-gear rotational frequency; 18rpm (counterclockwise rotation)
internal gear rotational frequency; — 10rpm working liquid flow rate; — a part for 1000mL/ amount of processing clearances; — 80-micrometer <dry type polish process> finishing machine: — double side lapping machine 24B-5 L type (product made from speed FAMUJAPAN)
surface plate appearance: — 1,592mm surface plate bore: — 554mm processing pressure force: — number of 35kPa top board revolutions: -10rpm (circumference of a clockwise rotation)
number of lower lapping plate revolutions: — number of 40rpm sun-gear revolutions: — 18rpm (circumference of a counterclockwise rotation)
number of internal gear rotations: — 10rpm pad material: — SUBA800 (Rodel Nitta CO. make) — the barium carbonate of 0.1 microns of mean diameters — a semipermanent condition — carrying out — amount:of activity processing clearances 50 micron (25 microns of one side)
<Etching process> liquid presentation: 1(fluoric acid)/1(nitric acid)/8 (acetic acid)
Immersion time amount: After the liquid immersion during 1 minute, Lynn Synge <polishing process> finishing machine:polishing equipment 59 SPAW-II during 15 minutes (product made from speed FAMUJAPAN)
surface plate diameter: — 1,504mm processing pressure force: — primary polish; — 15kPa Secondary 4th [-]; Ten or less kPas rotating speed : 40rpm working liquid flow rate: — primary 3rd [-]; — 6 L/min (circulation) 4th; — 6 L/min pad material: — primary; — SUBA800 secondary - 3rd; 4004th SUBA; — the wafer sampled from each processing phase used as the object for the poly tex <assessment experiment approach> assessment It built vertically, and from the soffit, it was gradually immersed in the light etching reagent, the sample was created by the approach (angle-type etching) of etching aslant at the loose include angle 5 like drawing 1 according to the difference of time amount (progress), and the condition (extent and the depth of a processing damage layer) of a crystal was investigated. Drawing 1 (a) is the front view of a wafer 1, and drawing 1 (b) is the side elevation. A broken line 2 shows the immersion side of a light etching reagent. The photograph by the X-ray topogrph method observes and investigates the condition of a processing damage layer, and many sunspots are observed, so that the damage by processing is strong. The X-ray topogrph photograph of the wafer front face which is not etched and each etched part was taken, the point that a sunspot was no longer observed was searched for, and it asked for the depth 6 of the part, i.e., the depth of a damage layer, by count from the etching include angle.

[0018] Wrapping processing of what carried out the **** ring of the periphery of the AZUKATTO wafer cut from the example ingot was carried out further, and the obtained RAPPUDO wafer was used as the start ingredient. Dry type polish processing was performed for this RAPPUDO wafer ingredient on condition that the ****. The wafer after polish processing obtained here was made into the charge of a sample offering, and it observed by the above-mentioned assessment experiment approach. Drawing 2 was an X-ray topogrph photograph in which the result is shown, when the photograph of drawing 2 (b) in which it is the front face which carried out dry type polish, and the condition of a part with a depth of about 5 microns is shown from the front face was compared, the condition hardly changed drawing 2 (a), but it turned out that the depth of a processing damage layer is 5 microns or less.

[0019] Wrapping processing of what carried out the **** ring of the periphery of the AZUKATTO wafer cut from example of comparison 1 ingot was carried out, the obtained RAPPUDO wafer was made into the charge of a sample offering, and it observed by the above-mentioned assessment experiment approach. drawing 3 was an X-ray topogrph photograph in which the result is shown, and from photograph drawing 3 (a) of the wrapped front face, although it was observed that there are a processing damage and a crack clearly, it was observed that the sunspot of an X-ray topogrph decreases gradually and the front face to a depth of about 20 microns reaches about 1 law in the depth (photograph of drawing 3 (b)) which is 20 microns. That is, in the usual RAPPUDO wafer, it turned out that the depth of the processing damage layer is about 20 microns.

[0020] Wrapping processing of what carried out the **** ring of the periphery of the AZUKATTO wafer cut from example of comparison 2 ingot was carried out, and what etched further on condition that the **** was made into the charge of a sample offering. According to the above-mentioned assessment experiment approach, it observed about this charge of a sample offering. Drawing 4 was an X-ray topogrph photograph in which the result is shown, when the photograph of drawing 4 (b) in which the etched front face is shown and a condition with a depth of about 5 microns is shown from the front face was compared, the condition hardly changed drawing 4 (a), therefore in the case of the usual etched wafer, it turned out that there is nothing practical as for the depth of a processing damage layer.

[0021] What performed polishing for the charge of a sample offering after the dry type polish obtained in the example of comparison 3 example further on condition that the **** was made into the charge of a sample offering. According to the above-mentioned assessment experiment approach, it observed about this charge of a sample offering. It turned out that drawing 5 is an X-ray topogrph photograph in which the result is shown, and there is also no depth of the processing damage layer at the time of performing polishing processing after the condition's having hardly changed, therefore performing dry type polish of this invention practical if drawing 5 (a) compares the photograph of drawing 5 (b) in which the etched front face is shown and a condition with a depth of about 5 microns is shown from the front face.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is a conceptual diagram explaining the angle-type etching method. (a) is the front view of a wafer and (b) is the side elevation. The X-ray topogrph photograph of the point 3 on the interface which performed light etching of a wafer is taken, and the X-ray topogrph photograph of the lost point 4 is taken.
[Drawing 2] It is the X-ray topogrph observation photograph in which the condition of the front face of a wafer and the crystal of a inner layer acquired according to the example is shown. (a) is an X-ray topogrph observation photograph on the front face of a wafer, and (b) is an X-ray topogrph observation photograph of the layer of the depth with which a processing damage layer is no longer observed.
[Drawing 3] It is the X-ray topogrph observation photograph in which the condition of the front face of a wafer and the crystal of a inner layer acquired by the example 1 of a comparison is shown. (a) is an X-ray topogrph observation photograph on the front face of a wafer, and (b) is an X-ray topogrph observation photograph of the layer of the depth with which a processing damage layer is no longer observed.
[Drawing 4] It is the X-ray topogrph observation photograph in which the condition of the front face of a wafer and the crystal of a inner layer acquired by the example 2 of a comparison is shown. (a) is an X-ray topogrph observation photograph on the front face of a wafer, and (b) is an X-ray topogrph observation photograph of the layer of the depth with which a processing damage layer is no longer observed.
[Drawing 5] It is the X-ray topogrph observation photograph in which the condition of the front face of a wafer and the crystal of a inner layer acquired by the example 3 of a comparison is shown. (a) is an X-ray topogrph observation photograph on the front face of a wafer, and (b) is an X-ray topogrph observation photograph of the layer of the depth with which a processing damage layer is no longer observed.
[Description of Notations]
1 Wafer 2 Immersion Side of Etching Reagent
3 Viewpoint of Interface Which Performed Light Etching
4 Viewpoint of Layer by Which Processing Damage Layer is No Longer Observed
5 Etching Include Angle 6 Depth of Processing Damage Layer

[Translation done.]